

Comments on the draft proposal to amend the Code with respect to trace fossils

(Proposal, see BZN 60: 141–142, 215–216)

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In the recent proposal to clarify the meaning of the term ichnotaxon, Bertling et al. (BZN 60: 141–142) suggested that the Glossary definition of ‘work of an animal’ should be emended. To supplement the proposed definition of trace fossil, the draft included clearly worded lists of structures that qualify as trace fossils and otherwise. In the proposal, fossil cocoons, pupal cases, plant galls and spider webs are considered to be animal products instead of true trace fossils. However, a vigorous general discussion in the ichnologic community in July and August 2003 (Skolithos, 2003) resulted in a consensus that these terms include some structures that qualify as trace fossils, suggesting the need to refine the wording further. Such refinement is proposed herein to reduce ambiguity between trace and body fossils, delineating a sharper boundary around the ichnological realm.

Cocoon is used in the invertebrate literature with different meanings. Many insect cocoons are structures built of silk and different amounts of other materials to oviposit, or protect larvae and pupae (e.g. Chapman, 1982). *Pallichnus* Retallack, 1984, *Fictovichnus* Johnston et al., 1996, *Rebuffoichnus* Roselli, 1939, and *Teisseirei* Roselli, 1985 are available ichnotaxa for pupal chambers (or cocoons or pupal cases) found in paleosols (Genise et al., 2002). Fossil wasp cocoons have also been recorded but not named (e.g. Bown et al., 1997). Eleven ichnogenera are attributed to trichopteran (caddisfly) cases made with silk and various coarse materials in aquatic environments (e.g. Sukatcheva, 1982, 1999). The ichnotaxonomy of caddisfly cases is well developed. The first ichnogenus was erected by Bosc (1805) and, at present, this is one of the few ichnotaxonomic arrangements that utilizes ichnosubgenera (Sukatcheva, 1982). These cocoons involve behaviour (weaving) and modification of substrate (silk and other materials), thus qualifying as true trace fossils.

In contrast, the so-called ‘cocoons’ of clitellates (e.g. Manum et al., 1991) and puparia of dipterans (e.g. Chapman, 1982) are just secretions and tanned larval cuticles, respectively; they involve neither behaviour nor modification of substrate. These more likely qualify as body fossils. Thus, we consider all kinds of constructed cocoons (e.g. woven cocoons, caddisfly cases) as trace fossils, whereas simply secreted cocoon-like structures and larval cuticles, such as clitellate ‘cocoons’ and dipteran puparia, are body fossils.

Similarly, the proposal ruled out spider webs as traces because they were considered, along with eggs and pearls, as secretions (Bertling et al., 2003). However, in spider webs and egg cocoons, the producer weaves the silk in a second step into a construction (i.e. a trace; e.g. Foelix, 1982). Fossil silk threads from spider webs are exceedingly rare in the fossil record (Poinar, 1998); the oldest examples have recently been reported from Early Cretaceous Lebanese amber (Zschokke, 2003). Cocoons are also sometimes preserved in amber (Poinar, 1998). One ichnogenus of caddisfly cases, *Secrindusia*, is basically composed of silk with few if any clastic particles (Sukatcheva, 1999). Indeed, the morphology of fossil trichopteran cases shows a

continuum from structures composed almost entirely of silk to those in which silk is only sparingly used to cement other materials. It is impossible to demark a boundary between traces and non-traces based on the amount of silk incorporated within a structure. Regarding the proposed definition of trace fossil, in constructed webs, nets and cocoons, silk is considered to be the substrate that is modified by the producer.

In addition, the substrate to which these silk structures are attached may also be modified. Trichopteran silk nets and cases may play an important role in the deposition of travertine (Drysdale, 1999; Leggitt & Loewen, 2002). Silky webs, nets and cocoons are true traces, not comparable to eggshells or pearls, which are un-reworked secretions. Nor are they comparable with agglutinated foraminiferan tests, which incorporate sand grains actively on the cell wall. These tests may fully match the producer morphology, and as such they are considered body fossils.

Plant galls may be initiated by viruses, fungi, other plants and invertebrates, especially arthropods. Accordingly, diverse kinds of galls exist that may involve the abnormal production of organs or tissues, which in turn may be patternless or show a repeated size and shape (Scott et al., 1992). Ichnologically, it is important to consider that in insect-made galls, the larva grows by feeding from the plant tissues, pupates and emerges as an adult. In doing so, it produces a boring, pellets, a pupal chamber and an exit hole, all of them true traces that have been recorded in fossil leaves and stems (e.g. Scott et al., 1992; Labandeira & Phillips, 1996). In other cases, galls may preserve only the plant reaction tissue and as such may not qualify as trace fossils. The oviposition, plus the larval boring, pellets, pupation chamber and exit hole together make up a composite trace fossil inside the reaction tissue, similar to other traces in leaves, but with disproportionate development of reaction tissue. Besides, all recognized traces of phytophagy, not just galls, produce reaction tissue (Scott et al., 1992; Labandeira, 1998). It is impossible to rule out traces involved in galls, if only because they are surrounded by particularly developed reaction tissues. Moreover, the gall inducer often directly controls the growth, shape and consistency of the reaction tissue (even by DNA transfer). It is difficult in this case to decide where the behaviour of the gall inducer starts to be replaced by mere 'secretion' by the plant. Hence, the term gall should be discarded because it is ichnologically ambiguous, whereas more properly defined plant reaction tissue may be included as a clear example of a structure that does not qualify as a trace fossil.

In conclusion, the proposal by Bertling et al. (2003) is affirmed though slightly modified. The Code must be clear, and thus has to define ichnotaxon accurately. We propose to define an ichnotaxon as the name of a trace fossil (including burrows, borings and etchings, tracks and trackways, coprolites, gastroliths, regurgitaliths, nests, woven cocoons, spider webs, leaf mines, some type of galls, bite and gnaw structures).

Additional references

- Bosc, M.L.** 1805. Note sur un fossil remarquable de la montagne de Saint-Gerand-le Puy entre Moulins et Roanne, Département de l'Allier, appelé l'Indusie tubuleuse. *Journal des Mines*, **17**: 397–400.
- Bown, T.M., Hasiotis, S.T., Genise, J.F., Maldonado, F. & Brouwers, E.M.** 1997. Trace fossils of Hymenoptera and other insects and paleoenvironments of the Claron Formation (Paleocene and Eocene), southwestern Utah. *United States Geological Survey Bulletin*, **2153**: 42–58.

- Chapman, R.F. 1982. *The Insects. Structure and Function*. 919 pp. Harvard University Press, Cambridge, Massachusetts.
- Drysdale, R.N. 1999. The sedimentological significance of hydropsychid caddis-fly larvae (Order: Trichoptera) in a travertine-depositing stream: Louie Creek, northwest Queensland, Australia. *Journal of Sedimentary Research*, **69**: 145–150.
- Foelix, R.F. 1982. *Biology of Spiders*. 306 pp. Harvard University Press, Cambridge, Massachusetts.
- Genise, J.F., Sciutto, J.C., Laza, J.H., González, M.G. & Bellosi, E. 2002. Fossil bee nests, coleopteran pupal chambers and tuffaceous paleosols from the Late Cretaceous Laguna Palacios Formation, central Patagonia (Argentina). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **177**: 215–235.
- Johnston, P.A., Eberth, D.A. & Anderson, P.K. 1996. Alleged vertebrate eggs from Upper Cretaceous redbeds, Gobi Desert, are fossil insect (Coleoptera) pupal chambers: *Fictovichmus* new ichnogenus. *Canadian Journal of Earth Sciences*, **33**: 511–525.
- Labandeira, C.C. 1998. Early history of arthropod and vascular plant associations. *Annual Review of Earth and Planetary Sciences*, **26**: 329–377.
- Labandeira, C.C. & Phillips, T.L. 1996. A Carboniferous insect gall: Insight into early ecologic history of the Holometabola. *Proceedings of the National Academy of Sciences*, **93**: 8470–8474.
- Leggitt, V.L. & Loewen, M.A. 2002. Eocene Green River Formation “*Oocardium tufa*” reinterpreted as complex arrays of calcified caddisfly (Insecta: Trichoptera) larval cases. *Sedimentary Geology*, **148**: 139–146.
- Manum, S.B., Bose, M.N. & Sawyer, R.T. 1991. Clitellate cocoons in freshwater deposits since the Triassic. *Zoologica Scripta*, **20**: 347–366.
- Poinar, G. 1998. Trace fossils in amber: a new dimension for the ichnologist. *Ichnos*, **6**: 47–52.
- Retallack, G.J. 1984. Trace fossils of burrowing beetles and bees in an Oligocene paleosol, Badlands National Park, South Dakota. *Journal of Paleontology*, **58**: 571–592.
- Roselli, F.L. 1939. Apuntes de geología y paleontología uruguaya. Sobre insectos del Cretácico del Uruguay o descubrimiento de admirables instintos constructivos de esa época. *Boletín de la Sociedad Amigos de las Ciencias Naturales ‘Kraglievich-Fontana’*, **1**: 72–102.
- Roselli, F.L. 1985. Paleoicnología: nidos de insectos fósiles de la cubertura Mesozoica del Uruguay. *Publicaciones del Museo Municipal de Nueva Palmira*, **1**(1): 1–56.
- Scott, A.C., Stephenson, J. & Chaloner, W.G. 1992. Interaction and coevolution of plants and arthropods during the Palaeozoic and Mesozoic. *Philosophical Transactions of the Royal Society of London, B*, **335**: 129–165.
- Skolithos. 2003. Archives of SKOLITHOS@LISTSERV.REDIRIS.ES, Forum on trace fossils. RedIRIS. URL <http://listserv.rediris.es/archives/skolithos.html>, accessed October 3, 2003.
- Sukatcheva, I.D. 1982. The historical development of the Order Trichoptera. *Proceedings of the Palaeontological Institute of the Russian Academy of Sciences*, **197**: 1–111.
- Sukatcheva, I.D. 1999. The Lower Cretaceous caddisfly (Trichoptera) case assemblages. *Proceedings of the First Palaeoentomological Conference, Moscow, 1998*: 163–165.
- Zschokke, S. 2003. Spider-web silk from the Early Cretaceous. *Nature*, **424**: 636–637.

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Bertling et al. (BZN 60: 141–142) have proposed various changes to a new edition of the Code, which were commented on by Tubbs (BZN 60: 215–216). His comments show that major arguments obviously have not been put in a way fully comprehensible for the non-ichnologist. Among other things, he states it is not the case ‘that the Code draws a distinction between fossilized tracks and other “works” such as galls, coprolites and nests’ (para. 7). This necessitates two replies. In a separate note,